Sustainable coastal zones? A matter of "sense and sensibility": Comparative analysis between Aveiro Lagoon (Portugal) and Sepetiba Bay (Brazil)

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Sustainable coastal zones?
A matter of “sense and sensibility”

Comparative analysis between Aveiro Lagoon (Portugal) and Sepetiba Bay (Brazil)

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Abstract

Purpose – The purpose of this paper is to perform a comparative analysis between Aveiro’s Lagoon (Portugal) and Sepetiba Bay (Brazil), in order to understand the similarities and differences between these two coastal zones, in terms of human occupation.

Design/methodology/approach – This paper is supported by works (papers and scientific projects being developed) produced in Portugal and Brazil, by researchers from different areas of expertise.

Findings – These two coastal zones have a similar geomorphologic evolution, due to the fact that both appeared because of a sandy spit, which started to grow and separated these areas from the sea, converting them into sheltered coasts. It was because they are protected that these two study cases early became targets for human occupation. The anthropic impacts in the systems were sustainable until the middle of the twentieth century. Since then, however, the economic development options, based first in industry and second in tourism exploration, have compromised the natural healthy balance.

Practical implications – This paper could be a contribution to a scientific support for political decisions on the coastal zone management (namely in these studied areas).

Social implications – The paper provides and increases the knowledge of the coastal zones’ evolution and occupation – from a multidisciplinary perspective – produced and made available to scientists, local politicians, students and local populations.

Originality/value – The paper provides a truly interdisciplinary approach, which allows a better understanding of the evolution of these two systems, discussing the causes and consequences of human activities in both coastal areas.

Keywords Portugal, Brazil, Coastal regions, Economic development, Lagoon of Aveiro, Sepetiba Bay, Anthropic actions, Sustainability

Paper type General review
1. Introduction
Due to their extension at a planetary level, to the fast evolution they are subjected to (by natural and anthropic elements), as well as to their huge attractiveness to communities, coastal areas are complex territories hard to understand in their different components. They require an integrated and multidisciplinary analysis in order to achieve their efficient management. Coastal planning shall be strongly sustained by scientific studies that support management decisions. However, scientists cannot replace politicians in the decision-making process. Notwithstanding, it is indispensable that studies clearly define coastal areas’ evolutionary trends. On the other hand, it is of crucial importance that political options are clearly defined through appropriate legislation.

The main purpose of this work is to undertake a comparative analysis between two coastal systems, geographically distant one from another, with distinct environments (climate, physiography, history and socio-economic characteristics). However, they present several points of convergence and similar evolutionary trends. On the basis of a multidisciplinary approach the work produced by the authors (a transnational team) expresses the need for a holistic view in coastal studies. That will provide support to a more accurate and sustainable management of coastal areas.

2. Characterization of analysed areas
2.1 Aveiro
The lagoon of Aveiro is usually known by the wrong designation of “Ria de Aveiro”. As a matter of fact, “rias” are flooded river valleys, whose paradigm are Galician Rias. Located in the NW of Portugal, between the cities of Coimbra and Oporto, approximately between the latitudes 40°1’52”N and 40°31’N, presents a total length of 40 km, with a maximum width, in its central sector, of about 8 km (Figure 1). It is separated from the sea by a sandy spit of variable width (maximum up to 2.5 km and a minimum below 200 m).

Ria de Aveiro corresponds to a mesotidal lagoon with a tidal range of 3.2 m in spring tides and 0.6 m in neap tides (Dias et al., 2000). The circulation inside the lagoon is controlled by the tide.

The lagoon system occupies a total area of around 110 km². During the high tides, the underwater area varies between 83 km² (spring tide) and 66 km² (neap tide) (Dias et al., 1999). Four main channels are defined in the lagoon: S. Jacinto, Mira, Espinheiro and Ilhavo. It presents complex topography, characterized by large recent alluvial deposits, sometimes forming islands and islets. Average depth is about 1 m, achieving 4 m and even 8 m in the navigational channels and the harbour areas (Borrego et al., 1994).

The hydrographic system of Aveiro lagoon is dominated by Vouga River (length: 148 km; river basin: 3.635 km²) which produces, jointly with other small rivers (Antuã, Caster, Levira, Boco and Fontão) a total estimated fresh water flow of 40 m³/s (Vicente, 1985).

Water exchanges with the ocean are processed through an artificial inlet 1.3 km long, 350 m wide and 20 m deep. Tidal prism is 136.7 \times 10^6 m³ during maximum spring tides and 34.9 \times 10^6 m³ during minimum neap tides (Dias et al., 2000).

2.2 Sepetiba
Sepetiba Bay is located in Brazil, in Rio de Janeiro State, between latitudes of 22°54′06″ and 23°04′18″S and longitudes 43°03′42″ and 44°02′03″W (Figure 2).
It is a semi-confined body of water of 305 km², framed by the tidal plain of Guaratiba (east), by Marambaia sandy spit (south) and by offshore migmatitic islands and outcrops (west).

Accordingly to Lamego (1945), Sepetiba Bay corresponds to an initial and ongoing phase of coastline rectification by sandy spits. More mature phases of this process are found eastwards: e.g., Maricá, Saquarema, Araruama and Jacarepaguá lagoons.

In reality, three units compose the large Sepetiba – Angra dos Reis region (Figure 3). In the western side there is the Bay of Angra dos Reis – Paraty; the central unit is separated from the previous one by Ilha Grande; Sepetiba Bay is isolated from the central unit by some islands and islets, namely the islands of Itacuruçá and of Jaguanum. These islands give Sepetiba Bay a relatively high degree of confinement.

Figure 1.
Lagoon of Aveiro location
Some authors (e.g. Borges, 1990; Cunha et al., 2002) consider that Sepetiba Bay extends until the island Guapia. However, the definition now proposed gives more homogeneity to the referred units.

Sepetiba Bay presents an ellipsoidal outline, around 30 km long and some 15 km wide. The lower depths are in the east sector. Depths generally do not exceed 10 m, but in the main channel some areas can reach 20 m; catchment area to the bay is around 2,600 km² (Cunha et al., 2002).

3. Occupation: synchronies and contrasts

Considered coastal systems present several similar characteristics:

• they are both located on Atlantic Ocean margins;
• both resulted from the development of sandy spits;
• being both sheltered areas, they have high levels of attractiveness to man (fisheries, ports, tourism, etc.); and
• during the twentieth century they were chosen for the establishment of important industrial areas, resulting in high degree of contamination in several areas.
However, they had some different forcing mechanisms resulting from:

- different geographic locations (different latitudinal locations one on the eastern and the other on the western shore of the ocean; one in the northern hemisphere and another in the southern) and, consequently, different oceanographic and climatic contexts;
- in Aveiro, there is no evidence from significantly higher Holocene sea levels (e.g. Rodrigues et al., 1991); in Sepetiba, maximum Holocene sea level reached about 5 m above the present one (Martin and Suguio, 1978; Herz, 1991); and
- different human historical constraints resulting from their distinctive societal evolutions.

3.1 The sandy spit

Both (Aveiro and Sepetiba) coastal systems resulted from the growth of a sandy spit that separated each of them from the Atlantic Ocean.

3.1.1 Aveiro. In the Aveiro region, when the mean sea level has reached the present one, coastline corresponded to a wide bay clearly open to the Atlantic Ocean (Dias et al., 2000).

Due to an abundant sediment supply provided by the Douro and other northern rivers a sandy spit started to grow from Espinho southwards. This spit eventually confined the former bay originating the Lagoon of Aveiro (Girão, 1922; Souto, 1923). Due to the spit sheltering effect several formerly open sea areas became emerged lands (Figure 4). This process was forced by the NW quadrant dominant wave climate, inducing a littoral drift directed southwards (e.g. Bastos, 2009).

The formation of this new coastline created favourable conditions for the establishment of populations, who could find there a propitious environment to the exploitation of natural resources, namely fisheries and salt, as well as to the use of the shelter provided by the sandy spit as natural harbours, thus enabling the development of maritime trade and navigation.

3.1.2 Sepetiba. After the transgressive maximum, when mean sea level reached approximately the present one, Sepetiba area corresponded to a wide bay open to the Atlantic Ocean. Due to the existence of Marambaia rocky outcrop and the availability
of sediments supplied namely by Guandú and Itaguaí Rivers, a sandy spit grew from west to east (Lamego, 1945). This process has clear analogies with the case of Aveiro. However, possibly due to the higher average depth, the spit’s growth was induced by littoral circular currents, generated by simple friction and moving from west to east, would transport fluvial sediments deposited in the north of the bay. Meeting of the inner and outer currents at the entrance of the bay have been responsible for the sandy spit growth (Figure 5) (Lamego, 1945; Roncarati and Barrocas, 1978).

Figure 4.
Reconstitution of the former coast between Espinho and Cape Mondego

Note: Exactly as the original map
Source: Extracted from Souto (1923)
As well as in Aveiro Lagoon, the modification of the coastal stretch of Sepetiba transforming it into a sheltered water body with strong potential to be used as a natural harbour, created a strong appetite for its occupation by human communities.

3.2 Records of human occupation

3.2.1 Aveiro. Attractiveness of the old Bay of Aveiro is attested by the successive occupation of its margins by antique populations (Oliveiros, 1984). However, exploitation had been greatly increased from tenth century onwards due to the said sandy spit growth. As a matter of fact, the spit progressively created more sheltered areas that favoured a more intense ownership and exploitation of natural resources (especially salt, fishing and navigation), giving the region opportunities to prosper. The progressive increase in the degree of confinement made this bay/proto-lagoon one of the regions where marine resources were more intensely exploited in the west facade of the Iberian Peninsula.

The prominence and affirmation of Aveiro region was simultaneous to prominence and affirmation of Portugal as an Independent Kingdom or, in other words, “the Lagoon of Aveiro and Portugal were formed at the same time” (Oliveira, 1988).

To that end, natural factors (morphodynamics and climate) contributed, along with military, political and socio-economic circumstances, which were congregated to create a generally favourable context. In fact, in the eleventh century the sandy spit, that would confine the Bay of Aveiro from the ocean continued to grow (Figure 6). Population excess in the zone between Douro and Minho Rivers, northward of Aveiro, and consequent strong deforestation and agricultural increment had certainly decisive importance. As a consequence, fluvial sediment transport and subsequent fluvial supply and littoral drift were strongly strengthened. That abundance of sediments was
the principal forcing mechanism to the sandy spit growth and the extensive dune fields built in it since that time (Dias, 2009). However, climatic factors also had great relevance: since the mid-tenth century a period of climatic amenity had begun, with longer summers, known as the Medieval Warm Period (Lamb, 1965) or Medieval Climate Optimum which favoured agriculture, in general, and was in the basis of demographic growth felt all over Europe (Bath, 1984).

In such a discussion it is always difficult to establish precise cause and effect relationships. Another factor to be considered is technological development, especially in agricultural practices, such as that of ploughs. The overall result was extensive deforestations and clearings in order to allow the creation of agricultural fields. Around the thirteenth century, by the end of the Medieval Warm Period and beginning of the Little Ice Age, it is estimated that half of the forests that formerly covered four-fifths of western and central Europe had disappeared (Fagan, 2008). Although specific data are not available to the sediment supplier area (between Douro and Minho Rivers), the geomorphological, historical, economical and sociological reasoning enables to infer that the situation had been similar if not worse.

With the strong sedimentary supply, resulting from the intensification of agriculture, the sandy spit continued to grow quickly. This means that, throughout the eleventh and twelfth centuries, the entire northern half of the Aveiros’s bay was getting protected from direct impact of the waves of the Atlantic and gradually being transformed, becoming little by little a semi-confined environment (Bastos, 2006). That was the birth of lagoon of Aveiro.
At the same time, deep structural socio-political changes occurred in this region. Approximately 60 km south of Aveiro, Coimbra, that Christians had reconquered and lost a few times, was definitively conquered in 1064 (e.g. Almeida, 1967). The border line between Christians and Muslims moved to Mondego River. The entire region surrounding the referred bay was now pacified, serving as a “safety valve” for the population excess that existed between Douro and Minho (Coelho and Homem, 1996). This migratory flow was certainly amplified, not only by existing opportunities in a newly conquered area, but also by the new sheltered coastal environments that progressively were being constituted.

In 1143 the independence of Portugal was recognized (through the Zamora Treaty). Some major cities (such as Santarém and Lisbon) were conquered moving the permanent border southwards, to the Tagus River. The war zone definitively moved away from the region of Aveiro. Along with the Portuguese territory definition process, the Aveiro’s bay became increasingly confined, progressing to the formation of a lagoon. New environments were being formed that were increasingly exploited. With the sandy spit fast growth the area sheltered from the direct incidence of the energetic Atlantic waves was being strongly enlarged. Around 1200, the sandy spit was already located nearby Torreira (Oliveira, 1988), NW of Aveiro and about 30 km of Espinho. It was a whole system in rapid transformation, which not only made viable an easier exploitation of natural resources, but also provided new environments and new opportunities that would be quickly explored by man.

Amongst the resources then extensively exploited, we shall emphasize: salt (benefiting from the abundance of salt water but without high energy waves); ports (which took advantage of an easy entry to the system and a large sheltered area); fisheries (either fluvial, within the bay and in the open sea) and agriculture (benefiting from the rich sediments deposited in the margins of the bay and from newly formed islands). In such conditions, it is not surprising that a clear trend for population growth could be identified in the region.

Amongst the mentioned resources, salt shall be pointed out. In northern Europe there are not favourable conditions, mostly of climate, to produce this product. Consequently, those populations were supplied by southern Europe. The Mediterranean area was a good salt producer but the journey to the northern countries was not easy: or it required long transport by land, which added many costs and was, at that time, dangerous due to abundant robbers; or it was exported by sea, significantly reducing costs, but at the risk of storms and, worse, of attacks of corsairs serving the Muslims, who dominated the southern part of Iberian Peninsula and the north of Africa. Under these conditions, the Atlantic coast of the Iberian Peninsula, under Christians’s power, was privileged as local of supply. Thus, in the twelfth century, the Portuguese expansion and trade of salt covered not only England and Flanders, but also the marginal regions of the North Sea and Baltic (Rau, 1984).

Since long ago the salt was produced in the northern Portugal estuaries, namely in Minho, Cávado, Lima and Leça Rivers. There is ample archaeological and documentary evidence of this activity (e.g. Lobo, 1812). When the stable border between Christians and Muslims was located on the Douro River, was certainly the salt produced in these estuaries that fulfilled the local needs. With the shifting of the border to the south and the pacification of the region of Aveiro, the exploitation of salt was strongly intensified and became available for the entire Christian world. The conditions for the production of salt are significantly better in Aveiro region than those existing in the Portuguese northern rivers. In Aveiro shores are large, gentle and steep
in contrast to the northern embedded estuaries, whose shores are small, narrow and inclined; water level presents only small variations in Aveiro, differently from the northern estuaries sometimes affected by violent floods; water salinity was almost invariant in the studied area, contrary to what occurs in the referred estuaries, where salinity is very dependent on river flows; insolation and atmospheric temperature are higher in Aveiro and rainfall is much lower than in the northern estuaries; the extent of the potential area to produce salt is much wider in the region that would become a lagoon than in the estuarine north shores, relatively tight.

Therefore, the definitive pacification of the region allowed Aveiro to quickly became, in national and international contexts, as a major salt producer, conducting to the extinction of many northern salt productions or leaving for them only a residual role. In the thirteenth century the salt of Aveiro reached the plenitude, becoming a major European supplier centre (e.g. Rau, 1984; Bastos, 2006). That was, perhaps, the first period of anthropization of the region.

3.2.2 Sepetiba. Geomorphology of Sepetiba Bay, conferring semi-confined and sheltered environments, was also the most important factor in the attractiveness of this area. However, comparing to the Aveiro case, the historical process was completely different. In the studied European area, different civilizations succeeded in the shores of the bay, each one more technologically developed than the previous, expanding and intensifying the exploitation levels of the natural system; in the considered South American bay, populations remained at an early stage of development until the arrival of Europeans, maintaining the exploitation of the system at a low level. In any case, Sepetiba Bay attractiveness led to the scattering of human populations, whose settlements were strategically established in locations with greater wealth and diversity of food, protected from winds and with good visibility. Although many archaeological sites have been destroyed, 33 sambaqui (shell mounds) sites are still registered (Kneip, 1987).

In recent years, archaeological sites of Grinders-Polishers type were identified in the island of Marambaia indicating the use of the area, by indigenous groups, for the manufacture of axe blades and other polished artefacts (Kneip and Oliveira, 2000). Grinders-Polishers sites are also registered in other places, such as in Ilha Grande (Gaspar and Tenório, 1990; Tenório, 1992), the island of Sandri and Piraquara (Figure 3) (Oliveira and Ayrosa, 1991; Oliveira and Funari, 2005; Oliveira, 2006). All of this evidence demonstrates the strong attraction that Sepetiba Bay exerted on pre-colonial indigenous communities.

3.3 “Turning point”
Portuguese discoveries and intensive navigations had very strong impacts in both systems, leading to great intensification on the exploitation of natural resources.

3.3.1 Aveiro. Aveiro had grown in socio-economic prestige and reached its plenitude. In the sixteenth century, the salt of Aveiro prevailed in international markets (Bastos, 2009).

The discoveries period was of essential importance, particularly in terms of new routes and markets. Amongst other structural activities (salt production, harbour development, agriculture), codfish fisheries, salting and drying were of extreme importance in the region. For that a combination of several factors contributed: existence of experienced fishermen, a good natural harbour, a favourable climate for drying codfish and, of course, plenty of salt. In the mid-sixteenth century, Aveiro had numerous fishing ships that used to go to the recently discovered Newfoundland to fish cod (Godinho, 1983).
However, from the seventeenth century onwards, and mainly in the eighteenth century, the Aveiro inlet loses hydraulic efficiency. Water exchanges with the ocean dramatically decreased and, sometimes, the bar were even closed. In 1757, the inlet was in its southernmost position, next to Mira (Figure 6). The region became strongly insalubrious. Malaria and other diseases was a scourge (Neves, 1956). Production of salt, like other forms of lagoon exploitation, almost collapsed. Ships avoided to demand the harbour since the lagoon entrance was often very dangerous and the journey to the port of Aveiro had become long and insecure. Misery was spreading. Most of the population left the region. This was the most dramatic period in the history of Aveiro.

3.3.2 Sepetiba. After the “discovery” of Brazil, in 1500, Sepetiba region begun to be systematically used by Portuguese, that go there to search for natural resources and wealth (namely Brazil wood and other woods). Also corsairs and pirates used to attend the region, searching for the same products and, due to the proximity to Rio de Janeiro, also trying to find anchorage grounds not yet found by the Portuguese. Amongst the divergences and convergences between Aveiro and Sepetiba, intensive navigations were structuring elements: both systems became departure and arrival points to and from all known world.

The shipments of gold descending from Minas Gerais to Paraty, and from here through the coastal system to Guaratiba (Figure 3), after following to the city of Rio de Janeiro, intensified the foreign interest in this region. The constant presence of French ships in these waters becomes responsible for intense illegal entry of African slaves (among many others, e.g. Overseas Historical Archive, box 8, doc. 893; box 88, doc. 20415-20420) and by piracy of gold traffic. Coeval literature refers several corsair ships in waters of the bay, such as of the English Thomaz Cavendish (in 1591) and the Dutch Joris van Spilbergen (in 1614) (Mello, 1987). In order to prevent pirate attacks and their trade with locals several fortifications were then built to defend this coastline (Mello, 1987).

Several consultations were made to the Overseas Council: they conclude that in the first half of the eighteenth century to avoid French pirate vessels, it is need of a bodyguard ship in Rio de Janeiro and real actions to prevent the French settlement in Ilha Grande. Therefore, the Government of Rio de Janeiro decided to provide the construction of fortifications throughout Rio de Janeiro coast to prevent pirate actions (Oliveira and Funari, 2005; Oliveira, 2006).

Napoleonic French Invasions forced the Portuguese royal family to runaway to Brazil in 1808. They settled in Rio de Janeiro. There, the Portuguese monarch, João VI, concluded that the Bay was an appropriate location for navigation and product transportation. Indeed, this proved to be the case. Sepetiba was considered the “Gold Port” due to the fact that it received all the gold, came from Paraty, having Lisbon as destination. It shall also be noted that in the ports of the this bay, particularly Itacuruçá, Mangaratiba and Angra dos Reis (Figure 3), there was an intense slave trade (e.g. Overseas Historical Archive, Overseas Council, box 88, doc. 20415-20420; box 112, doc. 9317). Attracted by the greed, Sepetiba Bay was the scene for many battles between corsairs and King João VI soldiers.

Throughout economic cycles, occupation of Sepetiba Bay shores grew up and environmental exploitation levels increased. The port of Mangaratiba achieved great importance in this period. Meanwhile, with the construction of the railroad in the Paraíba valley, the coastal municipalities were left outside the coffee trade and exportation. The coffee crisis in 1870, the migration from plantations to new lands in São Paulo, the high price of slave labour and legislation preparing the abolition of
slavery in Brazil meant decisive blows to the declining economy of south Rio de Janeiro.

Sepetiba reached its apogee during the cycles of Brazil wood, gold, slaves and coffee. In sixteenth century, both systems (Sepetiba and Aveiro) had already been subjected to strong anthropization but they were both, from a natural point of view and regarding resource exploration, in an apogee phase. With the advent of the Contemporary Period, the situation tended to be reversed: in Aveiro with the natural inlet closing (eighteenth century) and its consequences; in Sepetiba with the constant pirate attacks (they never effectively stopped) and crises arising from the displacement of coffee plantations to the south (nineteenth century). At the same time, occurred the abolition of the slave labour and the economy tended to enter a new cycle.

3.4 Modern times: industrialization and tourism
With the arrival of the Modern Age's new technologies, new production practices, new transportation systems, new thinking, new behaviours and even new aesthetic tastes appeared. The society started to change rapidly. Everything was being modified.

3.4.1 Aveiro. After several failed attempts, Aveiro solved the serious problems of its natural inlet through the opening of an artificial one in 1808 (Oliveira, 1988). Despite successive works of fixing, correction and maintenance (e.g. Dias et al., 1994) it is still effectively working nowadays.

From the middle of nineteenth century onwards this new inlet provided the restoration of the lagoon healthiness and the socio-economic revitalization of whole region. It enabled the successful restoration of the main activities (salt, fisheries, navigation).

In the middle of twentieth century a heavy chemical industry complex was implemented in Estarreja (on the lagoon inner coast). Additionally, a paper pulp production unit was built in Cacia, just a few kilometres south of the referred chemical complex. Discharges from these and other industries strongly contaminated waters and sediment in several areas of the lagoon, namely introducing in the system heavy metals such as lead, chromium, nickel, mercury, cadmium, arsenic, copper and zinc. Simultaneously, the end of catch of “molicó” (vascular aquatic plants that grow in the lagoon and that were extensively used in agriculture as fertilizer) enhanced silting up and led to the extensive use of artificial fertilizers. Also chemical pesticides began to be intensively used in agriculture and other activities. At the same time an anarchic land occupation happened. The overall result was silting up enhancement and general environmental degradation. Nowadays the system only functions as a lagoon due to recurrent human interventions, such as dredging operations not only in the area of the artificial inlet, but a bit through the all system. At present the lagoon can be regarded as an “anthropo-lagoon”.

In addition to environmental degradation, tourism implementation and development has to be considered. The fashion of summer sea bathing was imported from northern Europe mainly in the first half of nineteenth century and essentially was used by high society with therapeutic objectives (Freitas, 2007). This usage was rapidly adopted by the whole society during the twentieth century and objectives were modified: it was transformed in a purely playful, hedonistic and pleasant activity. With the democratization of air travel and the mass tourism advent this became an extremely important industry that all regions want their share.

In the case of Aveiro lagoon the higher touristic potential was located in the sandy spit, and the natural obstacle formed by the lagoon itself had to be overcome. That was
reached with the construction of the Varela, Vagueira and Barra bridges, between the 1960s and the 1980s of the last century. Regional, national and foreign tourists were now able to easily attend the ocean beaches of the system. Everything became easy and the few fishing villages started to grow rapidly. The construction sector and the hotel industry in general began to build as close as possible to the sea or the lagoon trying to satisfy the requirements of demand. Resorts, holyday houses and many other infrastructures started to be built, often on the characteristic high dune fields of the sandy spit. Easy accessibilities transformed some new urban coastal areas, such as Barra Nova and Vagueira, into satellite cities of Aveiro.

This construction boom in the context of coastal erosion and shoreline retreat has become extremely problematic. As occurred in several other regions, eventually the coastline will collapse, and in order to protect buildings larger coastal defense structures have to be built. Eventually the coast will become completely unnatural, losing its ecological-protective role, and requiring larger and continuous taxpayers’ investments for maintenance of this artificial shoreline (Dias, 2005). The oceanic coast immediately south of Aveiro inlet is already completely artificial. After several past generations of coastal structures, it is presently defended by a 4 km long riprap, as well as by a very large and high “artificial dune”. Southwards several other groins and riprap structures have been built and this coastal stretch is probably one that more concerns bring to national coastal management authorities.

In addition to the evident environmental damages, during the stormy season (in winter) overwashes (both in maritime and lagoon littorals) often occur, putting people and goods at risk. In the attempt to avoid this situation and fight coastal erosion, protective structures have been built but they repeatedly need reconstruction and expansion. For instance, the oceanic coast immediately south of Aveiro artificial inlet is already affected by a 4 km continuous riprap, a groin field and a very wide and some metres high “artificial dune”. Southwards of this point several other groins and riprap structures have been built. All these structures need more or less periodic works of recuperation and repackaging. Nevertheless, this coastal stretch is probably that one that more concerns bring to the national coastal management authorities.

3.4.2 Sepetiba. In Sepetiba, strategic options for economic promotion seem to be not very far from those presented to Aveiro. The region had fallen into decline in the early twentieth century with the massive decrease in orange production that attracted to the Guaratiba-Sepetiba lots of people and goods. The region’s decline made poor populations closer to a lifestyle based on fishing and small-scale farming.

Heavy industry was, as in Aveiro, one of the solutions to the region. The INGÁ Mercantil, a zinc factory located in Itaguaí, next to the port of Sepetiba, is an extreme example of pollutant industry settled in the system. Having gone bankrupt by the end of the twentieth century, a large reservoir of highly contaminated fluids was left unsolved, becoming a serious environmental problem. In 2006, during a storm, it leaked 15 million litres of water with high concentration of heavy metals, contaminating vast area of Sepetiba Bay (Bufoni and Carvalho, 2009). It is a serious environmental liability still not solved.

As in Aveiro, in Sepetiba Bay, along with the option for heavy chemical industry we must add the tourism pressure. In an extensive and accurate analysis of this coastal system, Sepetiba Bay must include also Paraty and Angra dos Reis bays (the western part of the system), where touristic infrastructures and holiday homes proliferate. A quite relevant advantage over Aveiro is Marambaia sandy spit that is not of public
access (unlike in Aveiro). It is a territory subject to the administration of the Brazilian navy that uses it merely as a training camp where none can enter without competent and restrictive authority’s permission. However, due to its landscape beauty this sandy spit (as happened in Aveiro) can be a target to speculative interests that may completely degrade it.

4. Conclusions
Comparison of two sheltered coastal systems (Aveiro and Sepetiba) located in distinct geographical regions (Europe and South America) and different climatic, oceanographic, physiographic and sociological forcings, enabled the detection of many convergent aspects. Perhaps the most evident, but not surprising (due to the general coastal morphodynamics) convergent aspect is their morphologic evolution with many common traces. They were remarkably affected by the growth of a long sandy spit that gave strong degree of confinement to a large bay, creating sheltered coastal environments. As a consequence, new opportunities for natural resources exploration were generated, which means their attractiveness for man was strongly enhanced. Amongst the historical convergent aspects of these two systems exploitation shall be emphasized:

- fisheries were one the first natural resources exploitation activities, since both systems were rich in ichthyofauna and sheltered from the oceanic waves;
- the discoveries period was essential for both systems, by inserting them into a world of increasing globalization;
- being both sheltered systems their high potential for use as harbour areas were quickly exploited, which enhanced human pressure on those environments;
- both systems demonstrated good conditions for industrial complex settlements; in both systems that led to serious contamination problems, namely by heavy metals, whose solution has not yet been defined;
- both systems are subject to strong pressure from touristic housing and activities; both are suffering from the inherent consequences, namely impacts on the ecosystem, urban pollution, destruction of landscape heritage, substantive changes of cultural heritage, relevant sociological changes;
- although both systems sustainability are seriously compromised, convincing plans for ecosystem regeneration, at least in the most affected components, were not yet well defined and implemented; and
- taking into account the panorama of ongoing climate change, namely the mean sea-level rise, future perspectives are matter of concern even because extensive shore areas of both systems are located just above the present mean sea level and are intensively occupied.

Convergences found in both systems, in particular with regard to the history of exploitation of natural resources are not specific to the cases of Aveiro and Sepetiba. They constitute the basis of an evolution model that can be generally applicable to semi-confined worldwide coastal systems subjected to relevant human pressure.

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